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(71) Applicant *(for all designated States except US)*: **FORTUM OYJ** [FI/FI]; Keilaniemi, FIN-02150 Espoo (FI).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **HILTUNEN, Jyrki** [FI/FI]; Jännissuontie 28, FIN-04130 Sipoo (FI). **SUPPOLA, Kauko** [FI/FI]; Lohtistentie 71 B, FIN-07590 Huuvari (FI).

(74) Agent: **SEPPO LAINE OY**; Itämerenkatu 3 B, FIN-00180 Helsinki (FI).

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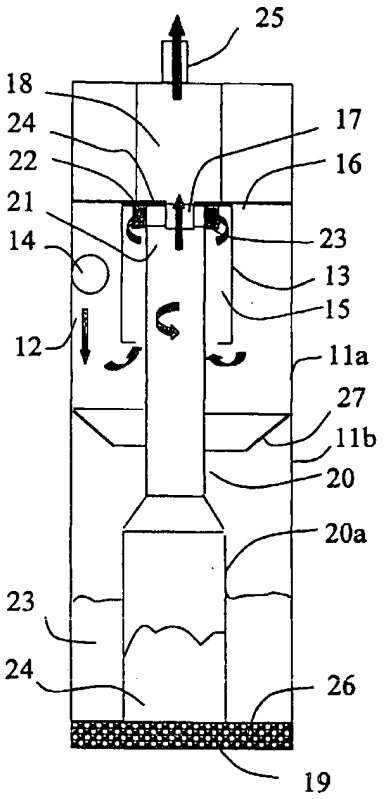
[Continued on next page]

(54) Title: DUST SEPARATION METHOD AND ARRANGEMENT OF A CENTRAL VACUUM CLEANER



(57) Abstract: Method and apparatus for removing solids from an air stream arriving at a central vacuum cleaner. According to the method, solids are separated from a dust-containing stream of air in two stages, in which case the air stream is first fed into a cyclone (12) in order to separate the coarse solids, whereafter the preliminarily cleaned air stream is fed into a second separator, where the finely divided solids is removed. According to the invention, the second separator used is, instead of or alongside a filter, a multi-inlet cyclone (13). In operation according to the invention, the finely divided solids can be separated effectively without a loss of suction efficiency due to clogging of the filter. Furthermore, the pressure difference of the cyclone is in general smaller than the pressure difference across a clean filter, and thus there is even initially more suction efficiency available.

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Description Claims

Dust separation method and arrangement of a central vacuum cleaner The present invention relates to the method according to the preamble of Claim 1 for removing solids from a stream of air arriving at a central vacuum cleaner.

According to a method such as this, solids are separated from a dust-containing air stream in two stages, the air stream being first directed to a cyclone, whereafter the preliminarily cleaned air stream is directed to a second separator, wherein the finely divided solids are removed.

The invention also relates to the dust separator arrangement according to the preamble of Claim 7.

In central vacuum cleaners the removal of solids from a gas is implemented with a single inlet cyclone and a paper filter. The present-day structure is shown in Figure 1, wherein the wall of the separator container is indicated by reference numerals 1 a and 1 b, the inlet port of the cyclone 2 by numeral 3, and the outlet port for discharge air by numeral 4. The inner wall of the separator container forms a cyclone separation chamber. The separator container 1 b is a separate vessel, which can be detached at the reducing collar 8 for purposes of emptying the collected dust. The paper filter is indicated by numeral 5.

Previously a foam plastic filter was used instead of a paper filter. After dust separation, the air travels via a 2-stage high-revolution blower 6 and either past the sides of the electric motor or directly to the outer air. If the said discharge air travels past the sides of the electric motor, it at the same time cools the motor. The coarse solids separated by means of the cyclone are collected on the bottom 7 of the separator container. The route of the solids from the wall of the cyclone separation chamber to the bottom of the container is indicated with an arrow line. In order to prevent the collected solids from dusting, there is usually arranged in the middle of the container a reducing collar 8 having the shape of a truncated cone. The cyclone chamber and the blower chamber are separated by a partition wall 9, through which there is led an outlet port 10, which is connected to the suction side of the blower of the central vacuum cleaner.

There are disadvantages associated with the PRIOR-KNOWN technology. Thus the single-inlet cyclone removes dust poorly, and most of the dust is found on the filter surface. The soiling of the filter reduces the suction efficiency over operating time. If the cleaning of the filter is neglected, the cooling of the motor suffers and overheating may lead to motor damage. The filter cartridge has to be replaced after a certain time of use, usually one year, since the pores of the filter paper are gradually clogged in spite of cleaning. This constitutes a continual operating cost.

It is an object of the present invention is to eliminate the disadvantages associated with the prior known technology and to provide an option of a new type for the separation and recovery of dust and corresponding solids from an air stream arriving at the central vacuum cleaner or the like, wherein the separating of finely divided and partly quite lightweight solids from a stream of air or gas must be carried out under vacuum.

The invention is based on the idea that the separating of solids is carried out in two separation stages, in which case the coarse material is first separated in accordance with PRIOR-KNOWN technology by means of a single-inlet cyclone, whereafter a multi-inlet cyclone is used as the separator means in the second separation stage. It has been observed, unexpectedly, that with the use of a multi-inlet cyclone in the second separation stage, the finely divided solids can be separated effectively without a lowering of the suction efficiency owing to the clogging of the filter. Furthermore, the pressure difference in the cyclone is in general smaller than the pressure difference across even a clean filter, and thus there is even initially more suction power available. It is an economic advantage that the cyclone option does not require parts (filter cartridge) to be replaced during the operating time.

More specifically, the method according to the invention is mainly characterized by what is stated in the characterizing part of Claim 1.

The arrangement according to the invention is for its part characterized by what is stated in the characterizing part of Claim 7.

Considerable advantages are achieved by the invention. Thus, the multi-inlet cyclone can easily be installed in the solids removal of a central vacuum cleaner without it being necessary to alter the structure of the separator device. The multi-inlet cyclone can be disposed between the single-inlet cyclone and the filter, or it can entirely replace the filter.

The multi-inlet cyclone forms a continuously regenerating filtering surface, and the solids separated by means of it can be collected in a separate collecting vessel. It can remove even small solids considerably more effectively than with a conventional single-inlet cyclone. The separation of small particles is important especially in the second separation stage. The separation efficiency of the multi-inlet cyclone is based on that the flow is brought close to the wall of the separation chamber by the control blades of the cyclone.

According to an advantageous embodiment of the invention, the multi-inlet cyclone and the first phase cyclone are placed within each other. This placement of the cyclones within each other the following essential advantages are gained: 1. Space savings inside the cyclone 2. the vortex accomplished in the first cyclone is preserved in the second cyclone and can be utilized there, i. e. the pressure loss is smaller when the vortex is NOT"KILLED", and; 3. disadvantageous flow disturbances do not arise in the channel between the cyclones.

This apparatus option is suited for use even in other targets in which it is desired to remove solids from the suction side of a blower at a point before the blower. These targets include the dust separators in the carpentry industry.

The invention is discussed below in greater detail with the help of a detailed description, with reference to the accompanying drawings.

Figure 1 depicts the principle of the structure of a state-of-the-art separation device as a cross-sectional side elevation, Figure 2 depicts a corresponding representation of the principle of the structure of the first preferred embodiment of the invention, Figure 3 depicts an option wherein a multi-inlet cyclone is disposed between the single inlet cyclone and the filter in a state-of-the-art separator, and Figure 4 depicts a plan view of the structure of the separation chamber of a multi-inlet cyclone and its vane system.

A multi-inlet cyclone is described in, for example, US Patent Specification No. 3,969,096.

By a multi-inlet cyclone is meant a cyclone having at least two inlets for directing a gas stream into the cyclone separation chamber. The inlets are preferably disposed symmetrically relative to the separation chamber.

Different separation device cascades are known from patent literature. The published patent application WO 93/19659 discloses a solution comprising a two-step separation device, the first phase being a normal single inlet cyclone and the second phase a filter.

WO 00/74548 discloses a separation apparatus comprising two cyclones in series. In this case, the second-phase cyclone is a normal single-inlet cyclone. In the known construction the vortex from the first cyclone is consumed in the perforated pipe, because the vortex would cause turbulence in the second phase and decrease the separation. The consuming of the vortex uses up a part of the pressure difference provided by the blower of the vacuum cleaner.

Figure 2 depicts a central vacuum cleaner dust separation arrangement that comprises a separator 11 A, 1 LB arranged between the suction pipe system and the blower. The separator comprises a first separation stage made up of a conventional single-inlet cyclone 12 for the separation of coarse solids and a multi-inlet cyclone 13 for the separation of finely divided solids. As shown in the figure, the dust-containing air stream is first directed via the inlet port 14 into the single-inlet cyclone 12 and thereafter into the multi-inlet cyclone 13. The multi-inlet cyclone is disposed inside the separation chamber of the single-inlet cyclone.

The separation chamber LLA of the single-inlet cyclone 12 is cylindrical, and the cross-section of the feed port 15 of the multi-inlet cyclone is, in the flow direction, annular relative to the central axis of the arrangement. The dust-containing air stream is fed into the separation chamber of the single-inlet cyclone at a point above the feed port of the multi-inlet cyclone. In this manner it is possible to prevent"short-circuiting"of the separators, in which the air stream would travel directly to the multi-inlet cyclone. The separation chamber of the multi-inlet cyclone is closed from above with an annular plate 16, through which there is led an outlet port 17, which is connected to the suction side of the blower 18 of the central vacuum cleaner. Cleaned air leaves via the outlet port 25. The separator is divided into two portions, L L A, 1 LB, by means of a reducing collar 27. It is advantageous to use a reducing collar 27, in particular if the separator container is low in height. The lower portion 1 lb of the separation container constitutes a separable vessel for the purpose of emptying the collected dust. The dipleg 20 of the cyclone is sealed against the bottom 19, for example, with foam plastic seal 26. The lower portion of the dipleg 20 is expanded 20a.

The multi-inlet cyclone 13 used in the invention has (see Figure 4) a separation chamber 21 that has an at least substantially vertical central axis and the cross section of the inner surface of which is preferably substantially circular, i. e. the separation chamber has rotational symmetry relative to its central axis. To the separation chamber there is connected a feed port 15 for air to be treated, the port having a substantially annular cross section perpendicular to the central axis. There is further arranged in the separation chamber a central tube 17 for the removal of air and a dipleg 20 for the recovery of the solids separated from the air. The pipe serving as the dipleg is preferably arranged so as to be concentric with the separation chamber of the single-inlet cyclone. In particular, if the dipleg is short, it is preferable to make the lower portion of the dipleg wider in order that the vortex inside the dipleg is

reduced and does not raise the already separated solids from the bottom of the dipleg. The separation chamber 21 has a guide vane system 22, by means of which the gas to be treated can be guided into the stream along the inner surface of the separation chamber in order to separate the solids from the gas under centrifugal force.

The bottom portions of the diplegs 11,20 of the cyclones 12,13 form each a separate collection container 23,24.

The pipe forming the dipleg 20 of the multi-inlet cyclone may be a helical pipe, such as a conventional air-conditioning pipe. Preferably the helix of this pipe is parallel to the stream of air in the single-inlet cyclone 12. The same applies to the vane system 22 of the multi-inlet cyclone, i. e. the vanes are arranged in the same direction as the stream arriving at the multi-inlet cyclone. In the case according to Figure 2, the inlet port 14 of the single-inlet cyclone is disposed on the side of the separator 11 so that, seen from above, the air stream forms a counter-clockwise vortex.

The vane system 22 of the multi-inlet cyclone comprises a plurality of vanes (in the case according to Figure 4,8 vanes), which are fastened, for example, by gluing or soldering between two rings 23,24, in which case the air stream is directed radially into the separation chamber from between the rings.

Figure 3 depicts an embodiment 42a, 42b of an application of Figure 2, in which the multi-inlet cyclone 33 is disposed as a separate element in the upper portion 42a of the separator, between the single-inlet cyclone 32 and the filter 34. Reference numeral 35 indicates the inlet port of the single-inlet cyclone, and reference numerals 36 and 37 indicate solids collection vessels. In the bottom portion 42 of the separator there are the bottom plate 39 of the separator and the seal 38 coming against it to seal the dipleg 43 against the bottom.

Numerals 40 and 41 indicate the blower and the electric motor and, respectively, the outlet port.

The structure of the multi-inlet cyclone 33 corresponds to the option shown in Figure 4.

Thus it has vanes 22 fastened between two annular plates, the air stream being directed into the cyclone radially.

This embodiment has the advantage that in practice all solids can be removed very effectively from the air to be cleaned. At the same time the interval between filter cleanings becomes long, since only the very lightest solids particles will reach the filter.

Description Claims

Claims 1. A method of removing solids from a stream of air arriving at a central vacuum cleaner, according to which method - solids are separated from the dust-containing air stream in two stages, in which case the air stream is first directed into a cyclone (12; 32) to separate the coarse solids, whereafter the preliminarily cleaned air stream is directed into a second separator, where the finely divided solids are removed, characterized in that - A multi-inlet cyclone (13; 33) is used as the second separator means.

2. The method according to Claim 1, characterized in that the dust-containing air stream is

first directed into a single-inlet cyclone (12; 32) and thereafter to a multi-inlet cyclone (13; 33).

3. The method according to Claim 2, characterized in that the diplegs (1 LB, 20,20a; 42b; 43) of the cyclone are connected each to a separate collecting vessel (23,24; 36,37).

4. The method according to any of Claims 1-3, characterized in that the multi-inlet cyclone (12; 33) is disposed inside the separation chamber of the single-inlet cyclone (13; 32).

5. The method according to Claim 4, characterized in that the separation chamber of the single-inlet cyclone (12) is cylindrical and the feed port (15) of the multi-inlet cyclone has an annular cross-section relative to the central axis of the arrangement.

6. The method according to Claim 4 or 5, characterized in that the dust-containing air stream is fed into the separation chamber of the single-inlet cyclone (12) at a point above the feed port (15) of the multi-inlet cyclone (13).

7. A dust separation arrangement for a central vacuum cleaner, the arrangement comprising a separator arranged between the suction tube and the blower, the separator comprising a first separation stage made up of a cyclone (12; 32) for the separation of coarse solids and a second separator for separating the finely divided solids, characterized in that the second separator comprises a multi-inlet cyclone (13; 33).

8. The dust separator arrangement according to Claim 7, characterized in that the multi- inlet cyclone (13) is disposed inside the separation chamber (1 LA) of the single-inlet cyclone (12).

9. The dust separator arrangement according to Claim 8, characterized in that the separation chamber (1 LA) of the single-inlet cyclone (12) is cylindrical and the feed port (15) of the multi-inlet cyclone (13) has an annular cross-section relative to the central axis of the arrangement.

10. The dust separator arrangement according to Claim 6 or 9, characterized in that the multi-inlet cyclone (13; 33) has a central pipe (20,20a; 43) which serves as a dipleg and which is arranged concentrically with the separation chamber (1 LA) of the single-inlet cyclone.

11. The dust separator arrangement according to Claim 10, characterized in that the central pipe (20) of the multi-inlet cyclone is expanded in its lower portion (20A).

12. The dust separator arrangement according to any of Claims 7-10, characterized in that the feed port (15) of the multi-inlet cyclone is connected to a separation vane system (22), which guides the air stream to the wall of the separation chamber.

13. The dust separator arrangement according to Claim 12, characterized in that the vanes (22) of the vane system are adapted to be parallel to the air stream vortex produced by the single-inlet cyclone.

14. The dust separator arrangement according to any of Claims 7-13, characterized in that the outlet port (17) of the multi-inlet cyclone is connected to the suction side of the blower of the central vacuum cleaner (18).

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A47L 9/16 // A47L 5/38, B04C 5/185
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A47L, B04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9835601 A1 (AKTIEBOLAGET ELECTROLUX ET AL), 20 August 1998 (20.08.98), figures 2,4, details 29,30,39	1-14
X	US 5145499 A (J. DYSON), 8 Sept 1992 (08.09.92), column 11, line 58 - column 12, line 14; column 14, line 33 - line 62, figures 2,4	1-14
A	US 5090976 A (J. DYSON), 25 February 1992 (25.02.92), figures 1-3, abstract	1-14

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 0074548 A1 (LG ELECTRONICS INC.), 14 December 2000 (14.12.00), figure 2, abstract ---	1-14
A	WO 0040135 A1 (FANTOM TECHNOLOGIES INC.), 13 July 2000 (13.07.00), figures 2,3 ---	1-14
A	WO 9319659 A1 (RACINE INDUSTRIES, INC.), 14 October 1993 (14.10.93), figures 1-8, abstract --- ---	1-14

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Information on patent family members

28/01/02

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